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ABSTRACT

Technical literacy is a prerequisite for effective participation in an information society. Generally defined, technical literacy is consonant with work-related functional literacy, but requires a wider range of skills and the ability to deal with specialized forms of materials in order to perform on the job or during training for skilled or semiskilled work. Technical literacy can be viewed as the intersection of technology and literacy. There are, for example, three ways in which it is related to technology: (1) the content is often about technology, (2) the purpose is usually designed to facilitate technology, and (3) the mode of delivery is increasingly likely to be through technology. Technical literacy also overlaps with other forms of reading, but there are at least five major areas in which it differs from them: content familiarity, format, semantic structure, task structure, and mode of delivery. Understanding the processes involved in technical literacy, accommodating individual differences, planning for effective document designing, and planning training for and through technical literacy all require the development and application of a broad framework based on well-constructed theory. (FL)

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Studying Technical Literacy in Today's Society

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Studying Technical Literacy in Today's Society

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To be literate in today's society requires that one process not only narrative but expository material; not only text but graphic material; not only static, paper presentations but dynamic displays through film loops, tapes, computer display, etc. One must not only comprehend but use the information immediately or in the future. Yet much of the theory and research available is only marginally applicable to analyzing the problems encountered and the processes used by asolescents and adults in processing technical material. The importance of technical literacy is increasing as a high-technology society places greater demands in training and on the job and as new technologies emerge for group instruction and self instruction (Fortier, 1982; Harrison, 1981).

"The literacy gap," the difference between the reading level of workers or trainees and the readability of the materials they must use, has been observed in high schools and technical schools (Corman, 1980; Thornton, 1980), among students in universities with open admissions policies (Wood & Hutson, 1979), in the military (Kniffin, Stevenson, Klare, Entin, & Slaughter, 1980) and in industry. While reducing the difficulty of the materials is part of the answer, there are limits to the usefulness of this approach: there is a shortage of trained technical writers (Braby & Kincaid, 1981, p 9); computer authoring, though increasing in sophistication, is at present useful only for a narrow range of materials; there are too many materials to "translate;" and there is inevitably a trade-off between grade level reduction and specificity (Kincaid et.al., 1980). There have also been useful but limited approaches to changing the task, as in substituting auding for reading (Sticht, 1972). It is therefore necessary to find ways to change the reader's approach to technical literacy. The first step toward that goal is to ask the nature of technical literacy.

Understanding the processes involved in technical literacy, accomodating individual differences, planning for effective document design and planning training

for and through technical literacy all require the development and application of a broad enough framework. Yet there is work that must be done before theory construction can be well-founded. One of the first steps needed in the serious and systematic study of any area is to define the phenomenon to be studied and to identify relevant bodies of knowledge. A next step is to extend the definitional process by contrasting the phenomenon with related constructs, thus defining its place within a semantic network. This step requires at least implicit recognition of important dimensions of difference between subsets within the larger network, which overlaps with and facilitates a later step, explication of the major dimensions of difference within the field to be studied. These steps are not sufficient to build a theory, but by organizing the field, making explicit the observed patterns, and provoking focused discussion, they may provide some of the groundwork necessary for development of a sound theory to guide research and practice.

In order to bring to bear on the topic of technical literacy the knowledge available in a variety of disciplines, this paper will (1) present a core definition of technical literacy and identify some of the bodies of knowledge which can be brought to bear upon the study of technical literacy; (2) discuss technical literacy as the intersection of technology and literacy; and (3) analyze differences between technical literacy and other forms of literacy. It is not the purpose of this paper to present a theory, but to explore in a non-technical way some of the dimensions that must be considered both in theory construction and in day-to-day decisions in training adolescents and adults to use complex academic materials (such as reading in the content areas) and job-oriented materials.

A Core Definition of Technical Literacy

Technical literacy is a prerequisite for effective participation in an information society. As used here, the term technical literacy overlaps to some degree with several other terms but is adequately defined by none of these. Technical literacy includes skills and strategies required to learn and to use high concept-density material (in print or in other visual modes) during training or performance for skilled, semi-skilled or professional employment.

Technical Literacy as the Intersection of Technology and Literacy

Technical literacy may be viewed as the intersection of technology and literacy. It is related to technology in three ways: (1) the content is often about technology, (2) the purpose is ordinarily to facilitate technology, and (3) the mode of delivery of technical literacy is increasingly likely be through technology.

Technical literacy is a subset of literacy and thus is related in greater or lesser degree to other forms of literacy. Distinctions between technical literacy and related constructs must be made in terms of differences in distributions of characteristics rather than dichotomies. Vocational reading, for example, overlaps to some extent with technical literacy but is ordinarily concerned with basic literacy, while technical literacy assumes a minimum of sixth to eighth grade reading skill. Job-related literacy is used by some writers (cf. Hutson & Stump, 1980) to include both basic and technical literacy, but by others to include only basic literacy. In the context of literature, literacy is sometimes used to mean a high degree of skill in processing plot, theme, mood, characterization and symbolization in novels, drama, and poetry and essays. The overlap of this aspect of literacy with technical literacy is small, though skill in determining theme is generic, and familiarity with essay form has relevance in technical materials.

There is substantial overlap between content area reading and technical literacy, particularly in the importance of determining the structure of ideas of a segment larger than a paragraph, noting cues to that structure, locating or constructing a brief overview of the text, keeping in mind clear purposes for reading, and integrating information in the text with information from other sources. Technical literacy, though, more often emphasizes reading for immediate application, offers less redundancy of information either in the text or in one's previous experience, forces more critical dependence upon information in charts, tables, and technical illustrations, and is more likely to take place in the site where the information is to be used, or during functional contexts during training (Shoemaker, 1960; Finch & Falls, 1981.)

The term technical literacy overlaps more with some meanings of the term functional literacy than with others. As used by Northcutt (1975) and others, functional literacy

encompasses survival reading skills in a variety of areas of life, such as reading recipes, filling out an application for a driver's license, reading directions on a medicine bottle. The emphasis is on minimal or basic skill levels, and the scope includes literacy for work as one of many areas. Functional literacy as used by Sticht (1975) is specific to work, and in fact, specific to occupational specialties within the armed forces, which range in level of reading skill required, (but typically require higher levels of literacy than those emphasized by Northcutt). More recent work by Sticht, Fox, Hauke, and Zapf (1977) emphasizes the fact that adequate literacy varies not only with the job specialty but with the criteria of performance selected. Functional literacy is defined by Diehl as "a variable construct--varying from individual to individual and from task to task" (1980, p. 17).

Technical literacy as used in this paper is consonant with a variable, work-related definition of functional literacy, but emphasizes the skill ranges that require more than basic literacy and ability to deal effectively with specialized forms of literacy required to perform effectively on the job or during training for skilled or semi-skilled jobs or professions.

Contrasts between Technical Literacy and Other Forms of Reading

Although there are wide differences within technical literacy and among the various other forms of reading, it is useful to blur some of these distinctions temporarily in order to focus on some of the differences between "typical" technical literacy and other common forms of reading. There are perhaps five major ways in which technical reading differs from most other forms of reading: content familiarity, format, semantic structure, task structure, and mode of delivery. Each of these will be discussed briefly.

Familiarity of Content

In most narrative material the content is largely familiar, perhaps in a new configuration of familiar elements or new specific instances of situation, character types, relationships. A small amount of novelty is embedded in a largely familiar background. There are, of course, exceptions, as in the Dune science fiction series, in which the situation, characters, relationships, vocabulary, and basic assumptions

about life are often unfamiliar. Even in many forms of expository material, content is relatively familiar, though the reader's attention may be drawn to less familiar aspects or implications.

In technical material, however, a relatively large percent of the material is often, at least at first exposure, unfamiliar. The reader who has never seen a frimfram in operation may have to construct, through reading, an image of what a frimfram is and does, how it acts when malfunctioning, and how to repair or replace it. On the other hand, some forms of technical material are mind-numbingly familiar. The meteorologist reads for the 4076th time the wind-chill chart; the editor consults once more the APA Publication Manual for the exact placement of the period in references of this type. In technical material, then, the familiarity of the content is often greater than in general reading but varies widely across task and across time for the same individual in the same task.

Format

The format of technical material also differs from the format of text encountered in most general reading. Most reading material (except for environmental reading--signs, ads, posters, cereal boxes) consists of large unbroken sections of text, perhaps punctuated by pictures. Some technical material also includes long text segments, but the "pictures" are likely to include complex illustrations, flow charts, graphs, etc., as integral parts. Braby & Kincaid (1981) state that "there is a firm requirement for the wide use of graphics in technical training material" (1981, p. 7.) Mikulecky and Diehl (1980) found that a third of the material used for reading on the job was graphic displays, and Crandell and Glock (1981) reported that graphics strongly facilitated readers' efficiency and accuracy in processing technical procedures, though Stone and Glock (1981) qualify this by saying that some types of information may be presented best in text, while other types of information are presented best in technical illustrations.

O'Donnell points out that the materials an employee must read may include "instructions, specifications, codes, manuals, employee contracts, memoranda, occupational

journals, employment notices and the like" (1982, p. 474.) Because skill in processing such a range of print and graphic material is critical to job performance yet cannot be assumed, Guthrie notes that some companies train their employees in skills such as interpretation of flow charts and company-related tables, diagrams, etc., and predicts that "the company teacher will be everywhere tomorrow" (1982, p. 495).

Formats found in technical materials, whether in print or computer display, static or dynamic, may range from graphic material embedded in text to text embedded in graphic material (Lipinski & Plummer, 1980). These nontext elements range in difficulty, and the ease with which one processes such mixed text is likely to change with experience. A flow chart, for example, may at first require careful study, yet later become just another form of text or even an aid to reading complex text (cf. Holland & Rose, 1982).

Other aspects, such as headings, bold-face print, boxed information, generous use of white space, are not used in most narrative material, but are frequently used in academic content area reading material, which overlaps in this respect with most technical reading material. In technical writing there is often emphasis on use of such devices, including quite literally a "mechanical" application through such procedures as computer-assisted authoring of instructional materials, conforming to such standards as preset practice and test formats, headings every two paragraphs, paragraphs and sentences of fixed length (cf. Kincaid, Cottrell, Aagard, & Risley, 1980). These procedures are likely to "be most useful when there is a high level of redundancy in the material being authored" (Braby & Kincaid, 1981, p. 6).

Semantic Structure of Materials

The semantic structure in technical materials may be complex, may be simple but unfamiliar, or may be critical either to safety or to success of an operation (Sticht et al., 1977b). The material often has high concept-density with little redundancy to aid comprehension (Stephenson & Ward, 1978). Precise relationships may be described (more or less well), and may be critical to comprehension. In such materials, "organizational patterns characterize entire works as well as single paragraphs " (Herber, 1978, p. 106), though this understanding may not be possessed or applied by all readers.

While the semantic structures in the text are often demanding and sometimes presuppose knowledge not possessed by the reader, that structure is in some cases more carefully framed and signalled in technical materials than it is in fiction or other general texts. Technical materials vary widely in degree of difficulty (Thornton, 1980) and in the consideration they show the reader, and readers vary in their ability to profit from cues about structure.

As a general principle, the more difficult the ideas contained in the text, the more helpful it is for the surface structure of the text (format, signal words, cohesive ties, indicators of text structure, etc.) to reflect the underlying structure of ideas. Although technical materials often employ aspects of format as a means to ease comprehension and highlight key information, they vary widely in the degree to which they signal the underlying text structure.

Task Structure

In most forms of reading, the task is either to read for pleasure or to read to learn and perhaps to remember for a test. Even in this small grouping there are some differences in task structure, particularly in the need to commit material to memory.

Technical reading tasks overlap with these, but include many situations in which the reading material plays a minor though sometimes critical role subordinate to a real-life task. For example, a technician learning to trouble-shoot a new word processor may read the manual for a while, look at the printer, look at the manual again, and adjust a disc drive. The counterman in the auto parts department may consult the parts guide just long enough to find the stock number for a solenoid for a 1979 Camaro (no mean feat until he learns to use the structure of the parts guide.) O'Donnell comments that even after taking a job, "one needs to use the skills the job requires, and that often involves reading occupational literature" (1982, p. 477).

Sticht and associates (1977b) have categorized the kinds of reading used on the job or during job training as "reading-to-learn," which is similar to the kinds of reading stressed in academic areas, and "reading-to-do", which includes following directions and quickly finding facts needed to complete a job task. Mikulecky and

Diehl have used these categories (with or without incidental learning) plus a category of "reading-to-assess" whether information is useful for a particular task, needs to be read more carefully later, whether to pass material on to someone else, etc. (1980, Appendix A, p. 74.)

The kinds of reading done during job training usually include "reading to learn" but on the job itself there is usually more emphasis on "reading to do." Braby and Kincaid, for example, point out that "the most common class of learning in Navy training is the learning of procedures" (1981, p. 8.) Sticht, Fox, Hauke, and Zapf (1977), surveying students, instructors and workers, had found that in the armed services 70% of the reading reported was for reading to do. Mikulecky and Diehl, surveying those already on the job, catetorized 11% of the responses as reading to learn , 63% as reading to do, and 26% as reading to assess.

Mode of Delivery

Another contrast is that while the primary medium through which reading has been achieved is hard copy (print on paper), the computer will increasingly be a primary medium of display for technical literacy. That is, technical materials will often be transmitted by computer display screen and related output devices, perhaps making use of even the microcomputer's ability to give feedback, to detect complex patterns and to request pertinent additional information. Terrell Bell, Secretary of Education, pointed out recently that the new microcomputers are not limited to a rigid broadcast schedule, as educational television has been, and can be targeted to individual learning rather than to groups (Manchak, 1982.) In the same context, Donald Senese, Assistant Secretary for Educational Research and Improvement, pointed out that these new technologies possess "a significant capacity for keeping the learner actively engaged for sustained periods; allow instruction to be adjusted to the rete and style appropriate to the individual learner, and provide the learner with a variety of previously unattainable experiences and problem situations through modeling and simulation." (Report of the U.S. Department of Education Task Force on Learning and Electronic Technology, 1981, p.2.) Computer-based delivery can be especially useful for graphics

and text-graphic combinations, whether during training or on the job. Stone (1981, p. 3) points out the ability of sophisticated computer systems to "display dynamic relationships under control of the student", giving the student or worker "the option of viewing, at his or her discretion, a wide variety of views of the subject of the graphic."

The computer may be used in training on technical literacy because of its ability to diagnose learning problems (when programmed appropriately though with the limitations noted by Burton & Brown, ,1978) to modify format, to respond to requests for help, and to use dynamic display capabilities to sensitize readers to text structure, question-answer reciprocity, and the structure of complex technical illustrations. The course-ware presently available generally has not attained this degree of sophistication. This discussion is not intended, however, to discuss in depth the learning needs or teaching strategies related to technical literacy.

The intent in this section has simply been to consider some of the ways in which the materials and tasks involved in technical literacy are similar to or differ from those encountered in other forms of reading. Several generalizations seem appropriate: On the whole, technical literacy differs from many other forms of literacy in content familiarity, format, semantic structure, task structure, and mode of delivery. Technical literacy overlaps to some degree with many other forms of reading; the differences can be expressed not as simple dichotomies but as differences in distributions--the relative frequency or difficulty of certain features. Within technical literacy, materials and tasks vary widely, but within specific job situations there may be a high degree of similarity in the tasks and materials used day after day.

Conclusions

As a preliminary step in bringing to bear upon the study of technical literacy the extant knowledge in several fields, this paper has attempted to define technical literacy and point out the many fields from which relevant information may be gleaned, to describe technical literacy as the intersection of technology and literacy (in its many definitions), and to point out differences between technical literacy and other types of reading. This is a limited but necessary step toward development of a coherent theory to guide research and practice.

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